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A systematic review and meta-analysis of valued obstetric and gynecologic (OB/GYN) procedures in resource-poor areas☆

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ABSTRACT

Background: Obstetric and gynecologic procedures are valuable in rural settings. Data identifying common procedures may better prepare surgeons to meet patient needs in remote settings.
Materials and methods: A literature review using key MeSH terms was performed according to methods described by the Cochrane Collaboration and PRISMA on studies that described obstetric and gynecologic surgery in rural high-income countries or any setting in middle- to low-income countries. Meta-analysis was performed using random effects modeling for odds ratios of cesarean delivery and hysterectomy as proportions of total surgical volume.
Results: A total of 195 studies were included for qualitative synthesis and 22 for quantitative analysis. Obstetric and gynecologic procedures made up a 19% of all surgical cases. As compared to other obstetric and gynecologic surgical procedures, cesarean delivery was the most common procedure with odds ratio of 2.39 (95% confidence interval 1.48–3.86), and hysterectomy was the second most common procedure with odds ratio of 1.60 (1.57–1.64). However, heterogeneity between the studies was extremely high and risk of bias was high, limiting quality of findings.
Conclusion: Greater provision of surgical care can be enhanced by defining which procedures are most needed, which include many obstetric and gynecologic procedures, most commonly cesarean delivery and hysterectomy.

1. INTRODUCTION

The poorest third of the world's population receives only 3.5% of the world's surgical procedures [1]. Surgical care in resource-poor areas may be more cost-effective, however, than other basic health provisions [2,3]. Improved surgical care in low- and middle-income countries remains a primary focus of the Millennium Development Goals of the World Health Organization (WHO) [4] and the Lancet Commission on Global Surgery [5], which includes strategy for "universal health care" that is also needed for surgical services within rural developed countries [6,7]. The call for broadly trained surgical providers to serve in "surgical deserts" has gained recognition on a global scale [8,9].

Obstetric and gynecologic (OB/GYN) surgical procedures, such as cesarean delivery (CD) and hysterectomy, are proposed to represent a large part of surgical burden in resource-poor areas [10,11,12]. Other procedures include reduction of ovarian torsion, treatment of ectopic pregnancy, ureteral injury or ureteral obstruction, as well as many other different obstetric procedures [13]. A detailed picture of which obstetric or gynecological procedures are needed in these communities remains unclear.

In contrast to areas with an abundance of surgical specialists, general surgeons have historically provided OB/GYN care where full-time obstetricians or gynecologists do not exist. In the United States, estimates reveal that rural surgeons perform up to 66%–71% of OB/GYN inpatient procedures [14–16], which make up 27% of the surgeon's overall caseload [17]. Hospitals with lower birth volumes (<240 births per year) are more likely to have general surgeons and family physicians attending deliveries than an obstetrician or a midwife [18]. Despite controversy as to which surgical procedures can be safely performed in rural hospitals, there has been consensus that emergency OB/GYN care must be available in rural facilities in high- and low-income countries alike [19–21]. In resource-poor areas, physicians and nonphysicians alike address surgical burden in resource poor areas [22].The American College of Surgeons, as well as Canadian and Australian initiatives, has developed training programs for general surgeons, family medicine physicians, and midwives to provide life-saving OB/GYN skills in rural areas of high-income countries [20,23–28]. Middle- and low-income countries have created a variety of programs that train nurses and nonphysician providers with a variety of titles, such as "assistant

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medical officers" [29] or "clinical officers" [30], to perform CD [31–35]. Meta-analysis comparing physicians and nonphysician providers revealed no differences in outcomes; however, this conclusion was reached with low confidence because there was a paucity of studies that could be included [30]. At present, data are lacking to characterize which type of provider performs OB/GYN surgical care in resource-poor areas and how they have been trained. As a result, current graduates may be "ill prepared" or "uncomfortable" for real-world practice in these challenging environments [36–38].

The objective of this systematic review and meta-analysis was to investigate the proportion of OB/GYN to total surgical case volumes in areas lacking surgical care, either in rural high-income countries or in middle- or low-income countries. Although CD and hysterectomy are hypothesized to make up most of the OB/GYN care in resource-poor areas, the proportion of these procedures compared to overall surgical volume remains unknown. Meta-analysis was performed to identify the frequency of CD and hysterectomy in comparison to other OB/GYN surgical procedures for purposes of identifying training needs of surgical providers entering a variety of resource-poor geographic settings.

2. METHODS

The study protocol was approved by the International Prospective Register of Systematic Reviews under #CRD42019135786. Using the PRISMA guidelines [39], relevant MeSH terms, including *general surgery*, *cesarean section*, *rural surgery*, *gynecology*, and *obstetrics*, were searched in Ovid, Cochrane Database of Systematic Reviews, Scopus, and CINAHL until November 1, 2019. A full description of the search terms is available online at www.crd.york.ac.uk. Inclusion criteria for systematic review included human populations in "resource-poor" areas for surgery. This was defined by authors of the included studies as either (1) populations in high-income countries that were lacking in surgical care in a rural location that specified that it had limited access to surgical care or (2) middle- and low-income countries that, by the Lancet Commission on Global Surgery's definition, are in need of more surgical providers. Studies were included if they reported on physicians or other surgical providers performing OB/GYN care in addition to all surgical care to examine what percentage OB/GYN care made of overall case volume. Commentaries, bulletins, or expert opinions were included in qualitative review because this literature has never been examined in a systematic review.

Independent screening by 2 reviewers (EB and NKP) was performed on title and abstracts of the primary search, followed by independent full-text assessment. Secondary searches were performed by the authors based on relevant references of the primary articles and included if agreed upon by more than 1 author in qualitative analysis. The Cochrane Collaboration's Risk of Bias Assessment Tool [40] in RevMan5 was used to assess quality of all studies included in the systematic review according to the Cochrane Handbook Guidelines [41] by 2 independent reviewers (EB and NKP). Any discrepancies in the study selection process or risk of bias assessment were resolved by group discussion consensus. Characteristics of the populations of included studies and the studies themselves were analyzed to better characterize the available literature on this subject using GraphPad Prism (Version 8.1.1). All data were tested for normal distribution using Kolmogorov-Smirnov tests and described as medians and 25th–75th interquartile ranges (IQRs), as recommended by Cochrane [42].

Table 1
Study characteristics of articles included in systematic review

	Study characteristics, N = 195 median (25th–75th IQR)
Study duration (y)	1.4 (1–3.5)
Total population encountered by hospital per study	662,066 (130,263–5,792,761)
Age of population receiving surgery (y)	27.5 (24.1–31.1)
Fetal mortality rate per 1,000 births	66 (48–89)
Maternal mortality rate per 100,000 births	522 (450–750)
CD rate (% per total births)	5.0% (1.9–11.4)
Percent of OB/GYN cases of total surgical volume	19% (83,717/446,001)
Total surgical procedures per 100,000 per year	159 (80–257)
Total surgical cases per provider per year	256 (121–353)
% Emergent cases of total surgery volume	55% (40%–92%)

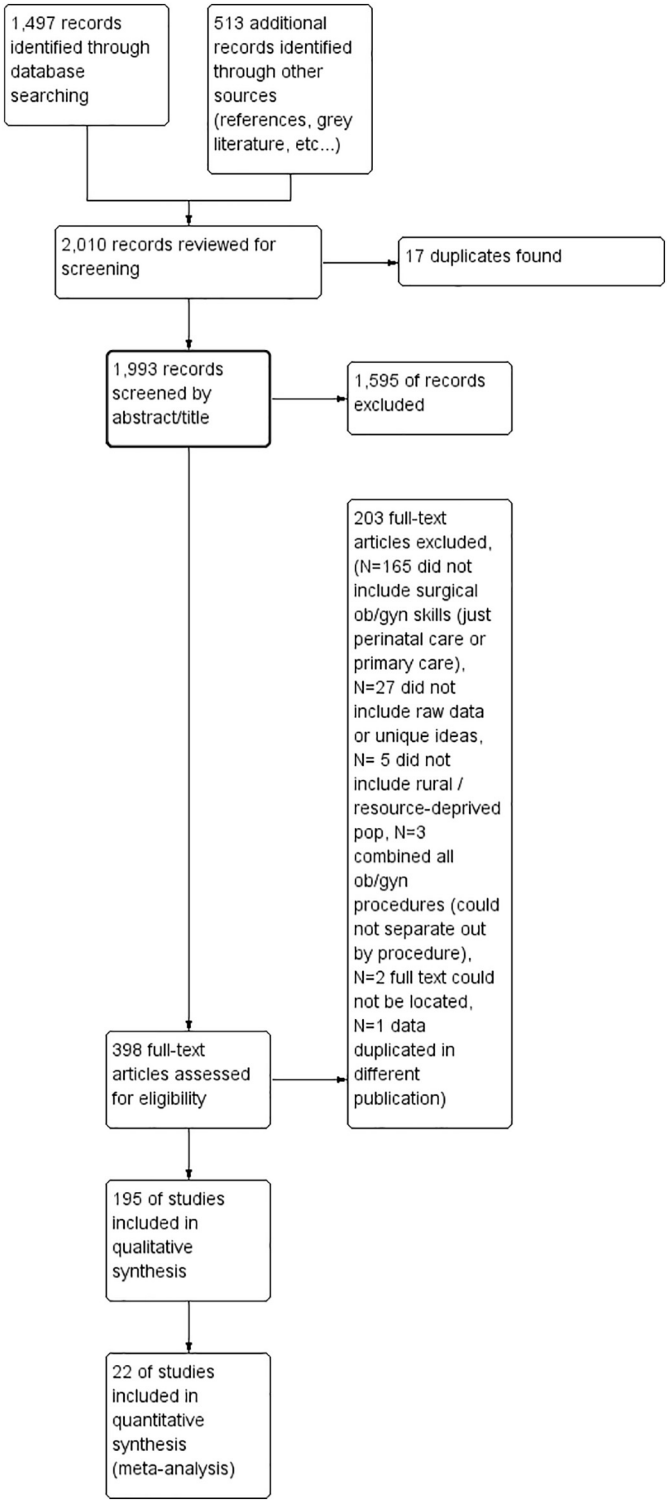


Fig. 1. Study selection process for systematic review and meta-analysis.

Meta-analysis was performed to better characterize the 2 most commonly reported major OB/GYN procedures performed by general surgeons in resource-poor areas: CD and hysterectomy. If articles reported only OB/GYN surgical procedures or the rates of limited selected procedures to serve as surrogates for overall surgical quantity (ie, only "appendectomy," "cesarean section," and "hernia"), they were excluded from meta-analysis to avoid skewing the analysis toward these procedures. Duplicated data were excluded, and the most complete data set from either study was used. Data extraction was performed using a standardized template in Excel, and these were verified for accuracy by the senior study author. RevMan5 was used to construct Forest Plots using the Mantel-Haenszel statistical method with random effects modeling, as recommended by Cochrane for clinical human outcomes articles [43]. Rates of these procedures as a fraction of total case volume were listed as odds ratios (ORs) and 95% confidence intervals (CIs). Because hysterectomy was hypothesized to be less common than CD, comparisons of hysterectomy to all other OB/GYN cases, with CD and without, were performed to examine the proportion of hysterectomy. Funnel plots were constructed to assess for publication bias of studies included in quantitative analysis in RevMan5 as well [44]. Heterogeneity for studies included in meta-analysis was assessed by χ^2 and I^2 tests using RevMan5.

3. RESULTS

A total of 1,993 articles were identified after preliminary search, of which 1,595 were excluded from full-text reading. After reviewing the 398 remaining articles in full text, 203 were excluded from qualitative review, mostly because of a lack of care for pregnant women in resource-poor settings. The remaining 195 studies were included in systematic review for qualitative description of the role of OB/GYN surgery in these settings.

The median study duration was 1.4 years (IQR: 1–3.5), as shown in Table 1. The median total population served by each hospital studied was 662,006 people (130,263–5,792,761). The median age of the patient population receiving surgery was 27.5 years (IQR: 24.1–31.1). The median fetal mortality rate was 66 deaths per 1,000 births (IQR: 48–89), and the median maternal mortality rate was 522 deaths per 100,000 births (IQR: 450–750). The median CD rate as a % of total births was 5.0% (IQR: 1.9%–11%), whereas the CD rate was far lower in low-income countries than in high-income countries. By including studies that had combined OB/GYN cases, the overall percentage of OB/GYN surgery was 19% of total surgical procedures (83,717 combined OB/GYN cases/446,001 cases total), but this rate varied greatly by study [17,45–48]. The median total surgical procedures performed per 100,000 people per year were found to be 159 (IQR: 80–257). Moreover, the total number of surgical cases per provider per year was found to be a median of 256 (IQR: 121–353). Finally, emergent cases made up 55% (IQR: 40%–92%) of total procedures, many of which were OB/GYN procedures, such as CD or hysterectomy for postpartum hemorrhage [49–52]. (See Fig. 1.)

Although the quantity of data in surgical obstetric care in resource poor areas was shown to increase over time, the overall quality was found to be at high risk of bias, as shown in Fig. 2. Almost all studies were completely retrospective in design and did not include any element of blinding to avoid selection bias, performance bias, or detection bias. However, most articles reported complete case logs (2 articles designed studies that looked at a single procedure or limited number of procedures to serve as surrogates for estimating surgical needs [32,53]), and thus, attrition bias was much lower and reporting bias was even lower because of full reporting of results. However, overall, articles were heterogenous in terms of population characteristics, study design, methods of evaluation, and assessments of outcomes. Thus, quality of the literature for this systematic review was graded as poor.

Meta-analysis was performed on the 22 studies that reported CD, hysterectomies, or both in addition to full surgical case volumes because these procedures were hypothesized to be the most common of OB/GYN procedures. Studies included in meta-analysis are listed in Table 2 for reference. Of all total cases, the most common OB/GYN procedure was CD (Fig. 3), with an overall OR of 2.39 (95% CI: 1.48–3.86), which was statistically significant ($P = .0004$). However, there was considerable heterogeneity among the studies that limit the confidence with which this conclusion was drawn (χ^2 $P < .0001$, $I^2 = 100\%$). Of the 15 studies that specifically reported hysterectomy, other OB/GYN procedures were statistically significantly more commonly performed when compared to all other OB/GYN procedures, including CD (OR 0.04; 95% CI: 0.01–0.11), as shown in Fig. 4. However, when CD was excluded, hysterectomy occurred more commonly than other OB/GYN procedures with statistical significance and an OR of 1.60 (95% CI: 1.57–1.64, $P < .00001$, Fig. 5). All corresponding funnel plots revealed relative symmetry with most studies demonstrating low standard error and high precision, representing a relative lack of publication bias (Figs. 6, 7, 8). However, these analyses had significant heterogeneity, like the CD analysis (χ^2 $P < .0001$, $I^2 = 100\%$), and limited the quality of the analysis.

4. DISCUSSION

This systematic review corroborates what previous literature has found: There is a need for surgical providers in resource-poor areas, as the rate of fetal and maternal mortality in areas without surgical care is much higher than in locations with appropriate surgical obstetric care. Compared with the median fetal mortality rate of 66 per 1,000 births found in this literature, the lowest rate is 1.8 in Monaco and the

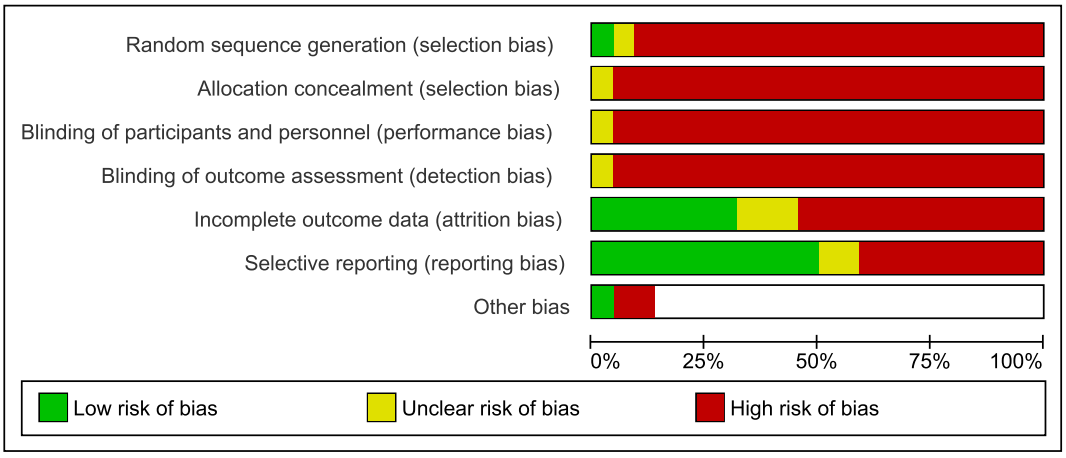


Fig. 2. Risk of bias assessment for studies included in systematic review.

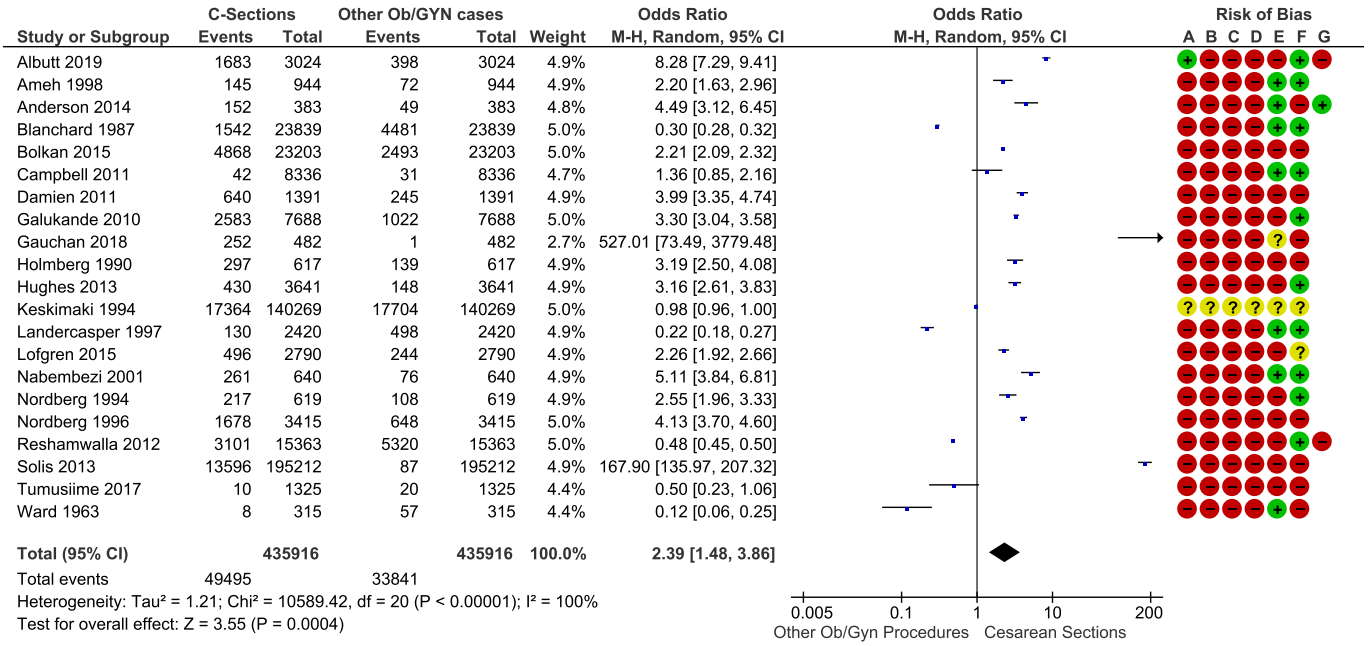
highest rate is 116 in Afghanistan, as of 2017 reporting (the rate in the United States is 5.8 deaths per 1,000 births) [54]. Moreover, maternal mortality is also elevated in areas lacking in surgical care, with the cohort in this study having a median of 522 deaths per 100,00 births (ranking 117th in worst fetal death) [54]. However, the association with higher quality of care and access to surgical providers from this analysis was strictly an association. It is unknown at present if the improved quality is due to a higher number of better trained surgeons or resources associated with surgical care, such as more numerous ancillary staff or more advanced facilities.

Additionally, this review found a deficit in the provision of CD, with a median CD rate of 5% of all births, which is far below that of areas with adequate surgical care, reflecting the importance of working toward the provision of this type of surgical care [55]. The CD rates found in this literature fell below the goal rate of 15% set forth by the WHO [55], which reflects appropriate provision of surgical care, as higher rates have been shown to correlate with unnecessary surgery and financial hardship for the poor without an improvement in maternal or fetal well-being [56–58]. The baseline CD rate found in populations with adequate surgical care in the United States and Canada is approximately 28% [59–61]. However, rural areas without surgical resources in high-income countries have rates as low as 3.8% [62]. Additionally, the studies included in this review had a median of 55% of emergent CD as compared to elective CD, and this finding is concerning given that emergent CD is associated with higher maternal mortality [63].

In terms of the percentage that OB/GYN cases represented relative to overall surgical volume, a proportion of 19% found in this review was higher than many reports, but lower than others, and reflects the need for standardization of surgical procedure definitions and reporting methods. Some studies reported only 1%–8% of total case volume being made up of OB/GYN cases [45,47,66], whereas others demonstrated up to 60%–96% [14,16,67–69]. Because OB/GYN procedures are a substantial fraction of the overall surgical care, and CD and hysterectomy predominate this fraction, these 2 procedures would be a reasonable metric to construct a curriculum for general surgeons who will be practicing in these resource-poor areas. Compared to the median of 159 procedures per 100,000 people found in this analysis, the lowest rate of surgical procedures per 100,000 is found in Chad, and the highest of 29,399 per 100,000 is found in the United States [70,71]. These findings underscore the need for general surgeons or obstetricians/gynecologists to be able to train across the 2 specialties to optimally address the disparities that exist in surgical care. Many articles in this review discussed strategies to provide this type of training, including rotations for medical students in rural or low-income areas [77–79], residency

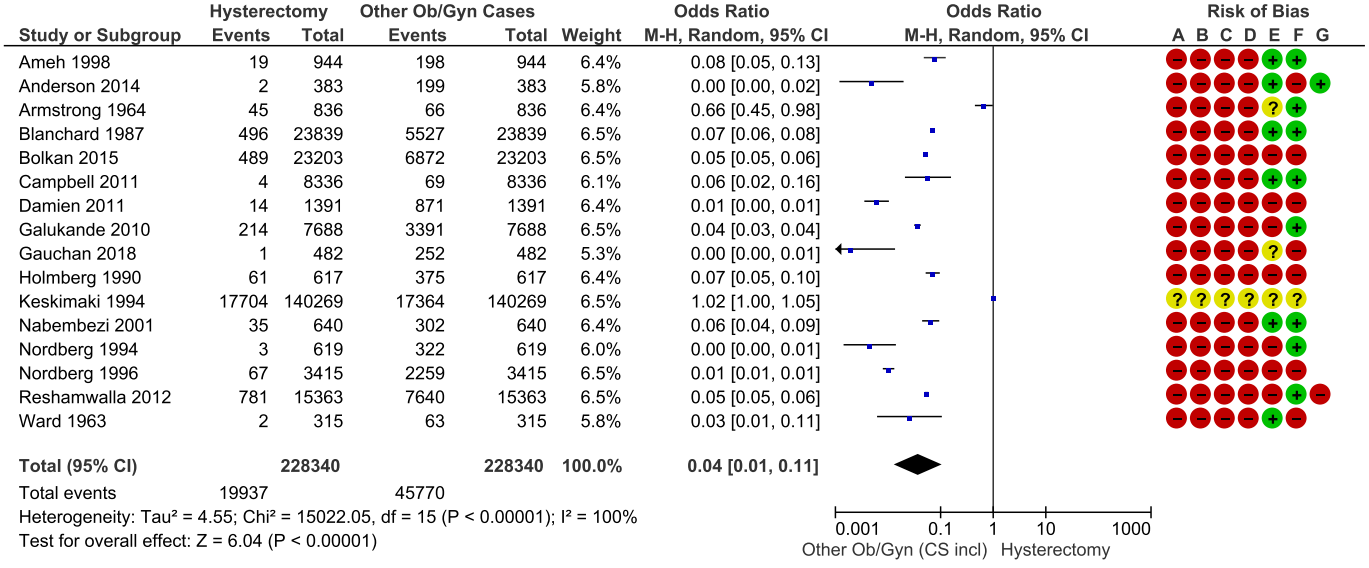
Table 2
Included studies in meta-analysis

First author	*Year of publication*	*Title*	*Country of study population*	*Reference information*
Albutt K	2019	Operative volume and surgical case distribution in Uganda's public sector: a stratified randomized evaluation of nationwide surgical capacity	Uganda	*BMC Health Services Research* (2019): 19: 104
Ameh EA	1998	Role of a general surgeon in obstetrics and gynaecology in a rural setting	Nigeria	*East African Medical Journal* (1998) 75(1): p. 27–29
Anderson JE	2014	Surgical conditions account for the majority of admissions to three primary referral hospitals in rural Mozambique	Mozambique	*World Journal of Surgery* (2014) 38:823–829
Armstrong WG	1964	Surgery in rural South Carolina	USA	*Journal - South Carolina Medical Association* (1964) Oct. 60:329–30
Blanchard RJ	1987	The epidemiology and spectrum of surgical care in district hospitals of Pakistan	Pakistan	*American Journal of Public Health* (1987);77 (11):1439–1445
Bolkan HA	2015	Met and unmet needs for surgery in Sierra Leone: a comprehensive, retrospective, countrywide survey from all health care facilities performing operations in 2012	Sierra Leon	*Surgery* (2015) Jun. 157(6): 992–1001
Campbell NA	2011	Operative experience of general surgeons in a rural hospital.	Australia	*ANZ Journal of Surgery* (2011) 81(9): p. 601–603
Damien P	2011	How are surgical theatres in rural Africa utilized? A review of five years of services at a district hospital in Ghana	Ghana	*Tropical Doctor* (2011) Apr. 41(2):91–5
Galukande M	2010	Essential surgery at the district hospital: a retrospective descriptive analysis in three African countries	multiple	*PLoS Medicine / Public Library of Science* (2010) Mar 09. 7(3):e1000243
Gauchan B	2018	Role of the general practitioner in improving rural healthcare access: a case from Nepal	Nepal	*Human Resources for Health* (2018) 16:23
Holmberg S	1990	Surgical rates in Africa. Variations and their possible explanations	Kenya	*Tropical & Geographical Medicine* (1990) Oct, 42(4):352–8
Hughes CD	2013	Ratio of cesarean deliveries to total operations and surgeon nationality are potential proxies for surgical capacity in central Haiti.	Haiti	*World Journal of Surgery* (2013) 37(7): p. 1526–1529
Keskimaki I	1994	Regional variation in surgical procedure rates in Finland	Finland	*Scandinavian Journal of Public Health* (1994), 22(2), doi. org/10.1177/140349489402200209
Landercasper J	1997	Spectrum of general surgery in rural America	USA	*Archives of Surgery* (1997) 132(5): p. 494–496; discussion 496–498
Lofgren J	2015	Cost of surgery in a low-income setting in eastern Uganda	Uganda	*Surgery* (2015) 157 (6): 983–991
Nabembezi JS	2001	Surgical output in Kibaale district, Uganda	Uganda	*East African Medical Journal* (2001) Jul. 78 (7):379–81
Nordberg E	1994	Major and minor surgery at a rural African hospital	Kenya	*Journal of Tropical Medicine & Hygiene* (1994) Jun. 97(3):138–44
Nordberg E	1996	Rates of major surgery by age and sex in a rural district in Kenya	Kenya	*Annals of Tropical Medicine & Parasitology* (1996); 90(2): 213–221
Reshamwalla S	2012	Snapshot of surgical activity in rural Ethiopia: is enough being done?	Ethiopia	*World Journal of Surgery* (2012). 36(5): p. 1049–1055
Solis C	2013	Nicaraguan surgical and anesthesia infrastructure: survey of Ministry of Health hospitals	Nicaragua	*World Journal of Surgery* (2013) 37:2109–2121
Tumusiime G	2017	The quality and utility of surgical and anesthetic data at a Ugandan regional referral hospital	Uganda	*World Journal of Surgery* (2017) 41: 370–379
Ward RV	1963	An analysis of surgical cases in a Nigerian mission hospital	Nigeria	*Canadian Medical Association Journal* (1963) Aug 24. 89:350–3



Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective reporting (reporting bias)
(**G**) Other bias

Fig. 3. Forest plot of CD versus other OB/GYN procedures as fraction of total surgical case volume.



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(**G**) Other bias

Fig. 4. Forest plot of hysterectomy versus other OB/GYN cases (including CD) as fraction of total surgical case volume.

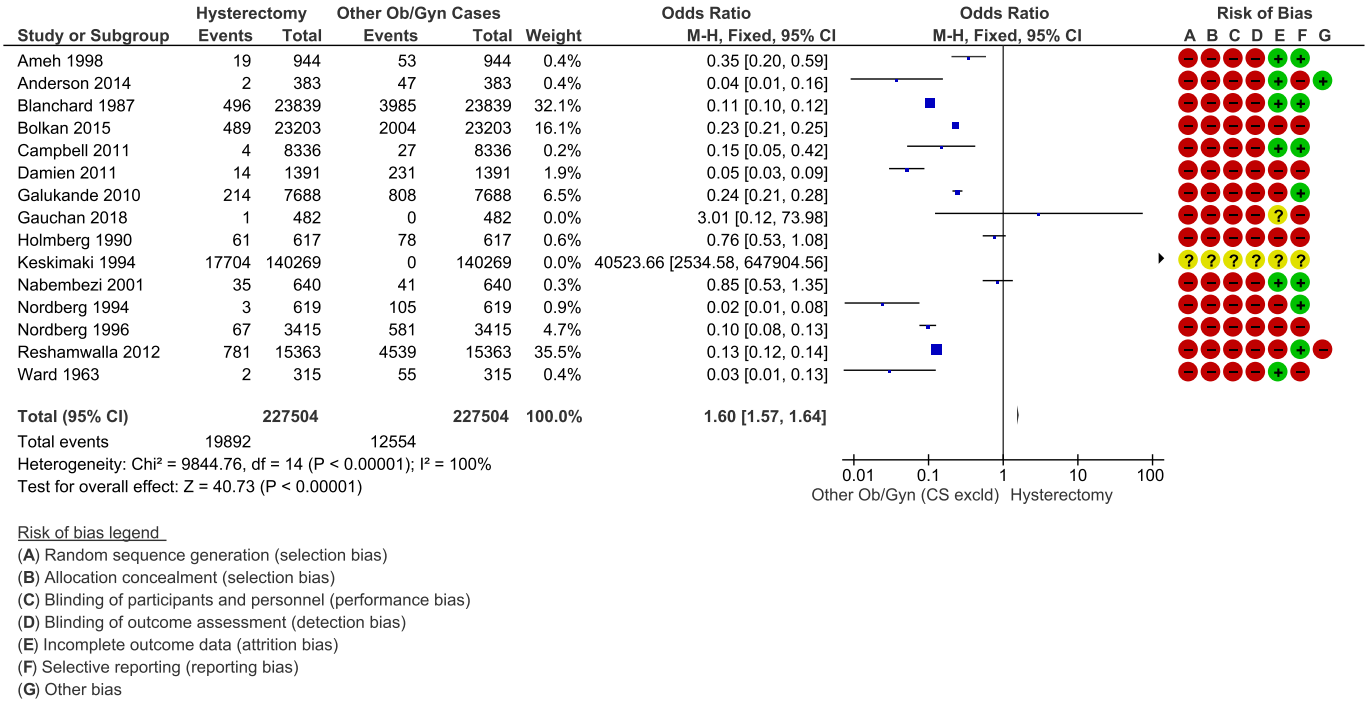

Fig. 5. Forest plot of hysterectomy versus other OB/GYN cases (excluding CD) as fraction of total surgical case volume.

tracts for rural or global surgery [23,28,80–103], and training courses for general surgeons to enhance their obstetrical skills if they desire to practice in an underserved location locally or abroad [13,60,115,121–135]. Although it is challenging to provide this broad-based surgical training, sustainable models have been created when continued support is provided to those recruited locally to the area in need [31]. Although nurses, midwives, and other types of nonsurgeon providers have been shown to provide safe outcomes in these remote areas, this literature showed that surgeons played a prominent role in the initiation and sustainability of these programs. More information detailing of the types of case-loads and techniques used to train providers in these successful ways is still needed to understand how to provide care to populations with different comorbidities, geographic locations, or deficits in surgical infrastructure [136]. Additional data are also needed to assess the costs of these programs and the long-term outcomes for the mothers and children to establish surgical care in as cost-effective, yet safe, a manner as possible to the areas that need it most.

In conclusion, the call for essential surgical procedures is being raised, but clarification is still needed regarding which procedures and at what rates. OB/GYN surgical skills make up a large proportion of surgical burden in areas with limited health care resources. Moreover, CD is one of the most cost-effective interventions of all health care, not just surgical procedures, because it typically saves the lives of 2 persons at the same time and is highly successful. This analysis provided qualitative descriptions about the available literature on the important role of OB/GYN surgery, as 19% of total surgical volume comprised OB/GYN procedures. The most common OB/GYN surgery was CD, followed by hysterectomy. However, there was still a

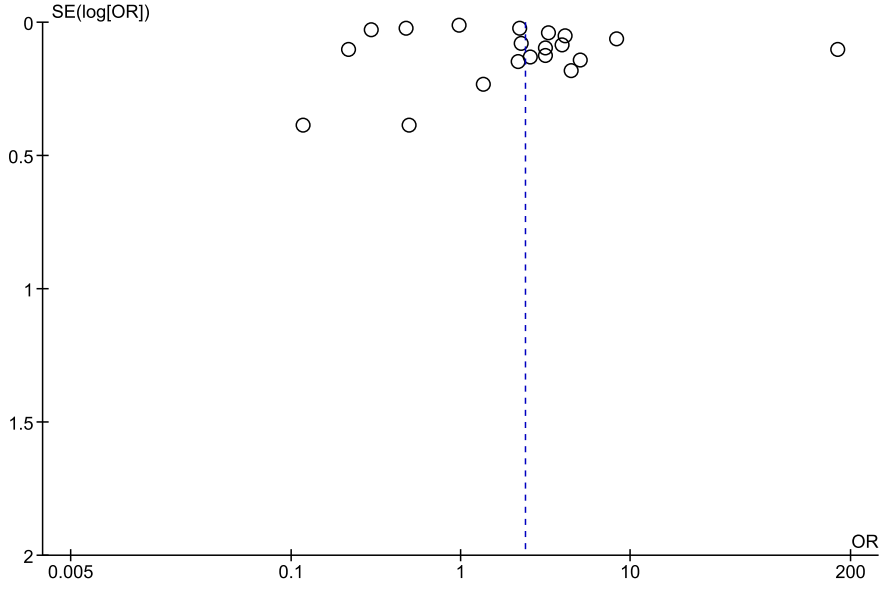

Fig. 6. Funnel plot of studies included in CD analysis for assessment of publication bias.

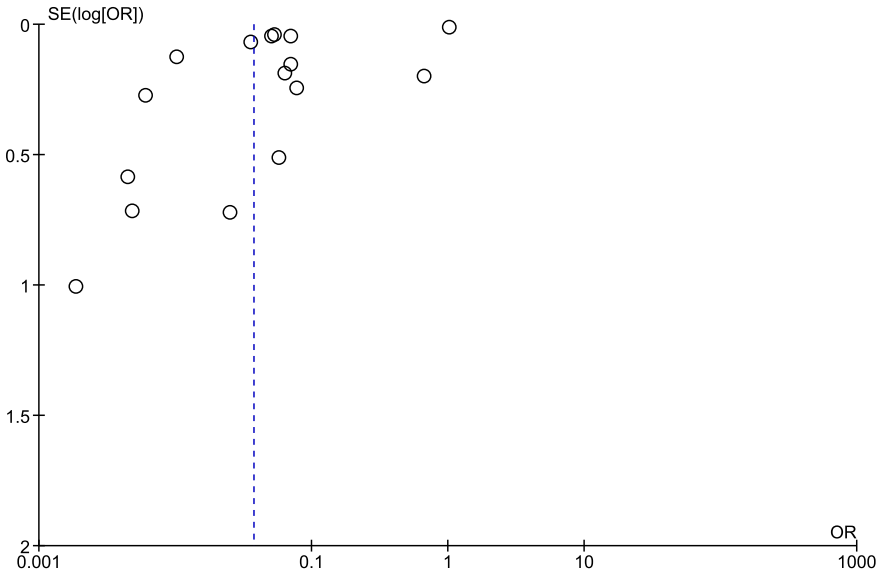

Fig. 7. Funnel plot of studies included in hysterectomy (CD included) analysis for assessment of publication bias.

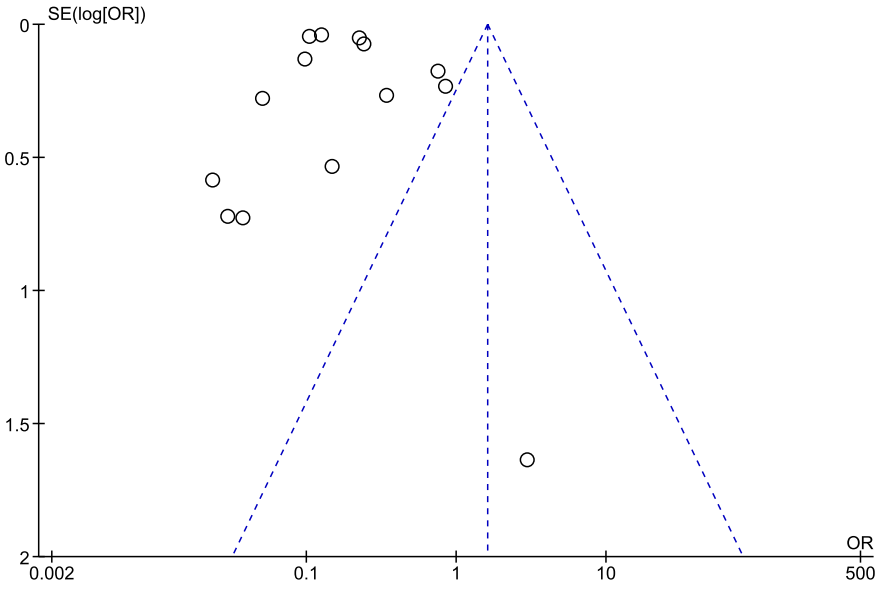

Fig. 8. Funnel plot of studies included in hysterectomy (CD excluded) analysis for assessment of publication bias.

deficit in provisions of CD, as the median CD rate was 5%, which fell below the recommended rate of 15% proposed by the WHO [55]. Strategies for streamlining training to increase capacity for CD, hysterectomy, and other surgical care were varied and isolated among rural high- and low-income countries. Standardization of data collection and more detailed descriptions of training methods can catalyze the development of training that precisely addresses the needs of underserved areas.

Disclosures

Author Contributions. NKP wrote the initial draft of the protocol for the systematic review/meta-analysis, and EB refined and submitted the protocol for approval by the International Prospective Register of Systematic Reviews. EB and NKP performed independent screening and full-text analysis of articles for the systematic review. EB and NKP performed independent risk of bias assessments for included articles. EB performed data collection for meta-analysis and analysis of data. EB performed construction of all figures, including forest plots and funnel plots. VB served as tiebreaker for discrepancies in study inclusion. NKP and EB performed final revision of the manuscript prior to submission.

Conflicts of Interest

The authors of this article have no personal, financial, political, or academic conflicts of interest to disclose.

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